N89-12583

WF/PC INTERNAL MOLECULAR CONTAMINATION DURING SYSTEM THERMAL-VACUUM TEST

D. Taylor, J. Barengoltz, T. Jenkins, K. Leschly, and J. Triolo
Jet Propulsion Laboratory
California Institute of Technology

ABSTRACT

The Wide-Field/Planetary Camera (WF/PC) uses eight Charge Coupled Devices (CCDs) as imaging sensors in the wavelength region from 1200 to 11,000 angstroms. The CCDs are operated at temperatures below -80°C for noise reduction and quantum efficiency stability. As a consequence, the CCDs are susceptible to very low levels of internal contaminants which affect the far ultra-violet (FUV) instrument performance. This concern is further magnified by the limited venting paths to the external environment.

During the recent system thermal-vacuum test of the WF/PC (February–March 1988), instrumentation was added to the WF/PC to characterize the internal molecular contamination and verify the instrument throughput down to 1470 angstrom. The following instruments were mounted on an access plate with view of the inside of WF/PC: A 15MHz temperature controlled quartz crystal microbalance (TQCM), a thermocouple pressure gauge, and an optical witness mirror. Four UV-sources were added to the Optical Stimulus used to verify the optical performance of the WF/PC. The optical stimulus simulates the F/24 beam provided by the Hubble Space Telescope (HST) to the WF/PC pick-off mirror mounted external to the camera.

Throughout the system thermal-vacuum test (37 days) the following data was collected of relevance to contamination:

- Temperature data for the WF/PC optical bench, internal electronic assemblies, CCDs, heat-pipe system, radiator, and the external thermal shrouds.
- TQCM data, with the crystal temperature set at -20°C during most of the test.
- Pressure data for the vacuum chamber and the internal WF/PC environment.
- WF/PC thruput data at 1470A, 2500A, and 4100A during each of the CCD cooldown cycles.

Analysis of the above data elements revealed the presence of two contaminants affecting the FUV performance of the WF/PC. The one contaminant (heavy volatile), is correlated with the electronic and housing temperature, and the contamination was significantly reduced when the electronics were operated below +8 to +10°C. The other contaminant (light volatile), was controlled by the heat-pipe temperature and was significantly reduced when the Thermal Electric Cooler (TEC) hot-junction temperature is below –40 to -50°C. These conclusions are supported both by TQCM data and WF/PC thruput measurements at 1470A.

The utility of contamination sensors located inside instruments during system tests was demonstrated. Vacuum chamber background readings could not reflect the internal conditions of interest because WF/PC is almost sealed, the background followed shroud and WF/PC external surface temperatures, and these external surface emissions would swamp the relatively low internal fluxes. The TQCM data internal to WF/PC provided information on the physical sources of contamination and possible contaminant species that affected instrument performance. The entire data set also guided remedial measures.

After the thermal-vacuum test and prior to final installation of the WF/PC into the HST, the WF/PC was modified in two areas:

- To enable on-orbit decontamination of the CCDs, heaters (66W total), were added to the eight heat-pipe/radiator saddles. This change provides a capability to boil-off the CCDs at temperatures above +10°C.

- To reduce the on-orbit outgassing rate of the high temperature volatile, patches were removed from the thermal blankets covering the electronic bays. This change reduces the expected operating temperature of the electronics by 2 to 3°C (down to between 0 to 5°C nominal).

Wide Field/Planetary Camera

- TWO CAMERA SYSTEMS

	WIDE FIELD	PLANETARY
• FOCAL RATIO	f/12.9	f/30
• COMPOSITE ANGULAR FOV	2.67 x 2.67 arcmin	68.7 x 68.7 arcsec
• NUMBER OF CCD CAMERAS	4 (2 x 2)	4 (2 x 2)
• NUMBER OF PIXELS	1600 x 1600	1600 x 1600
• WAVELENGTH COVERAGE	1200Å TO 10,000Å	1200Å TO 10,000
• NUMBER OF FILTERS	48	48

- SCIENCE OBJECTIVES –
  - DETERMINATION OF COSMIC DISTANCE SCALE (7x IMPROVEMENT)
  - TESTS OF WORLD MODELS AND COSMIC EVOLUTION
  - COMPARATIVE EVOLUTIONARY STUDIES OF DISTANT AND LOCAL GALAXIES
  - STELLAR POPULATION STUDIES TO VERY FAINT LEVELS
  - HIGH-RESOLUTION LUMINOSITY PROFILES OF GALACTIC NUCLEI
  - ENERGY DISTRIBUTION OF STARS AND COMPACT SOURCES
  - DYNAMIC MOTIONS IN SUPERNOVAE REMNANTS AND PROTO-STARS
  - SEARCH FOR EXTRA-SOLAR PLANETS
  - DETERMINATION OF CLOUD MOTIONS AND COMPOSITION OF PLANETARY ATMOSPHERES, THE DYNAMICAL FIGURES OF PLANETS, THE CARTOGRAPHY OF ASTERIODS AND SATELLITES, AND THE STRUCTURE OF COMETS

Figure 1

Wide Field/Planetary Camera

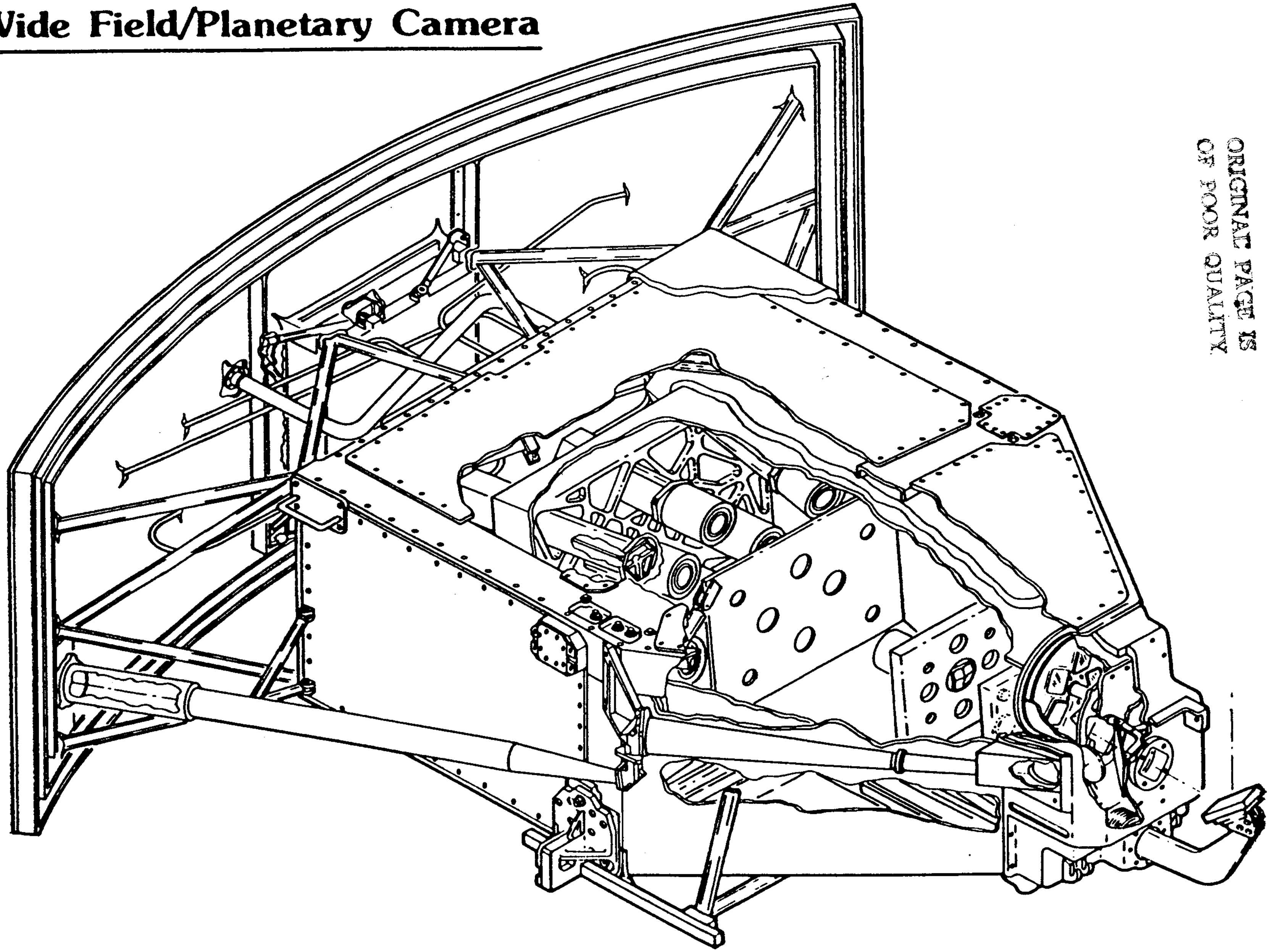


Figure 2

ORIGINAL PAGE IS
OF POOR QUALITY

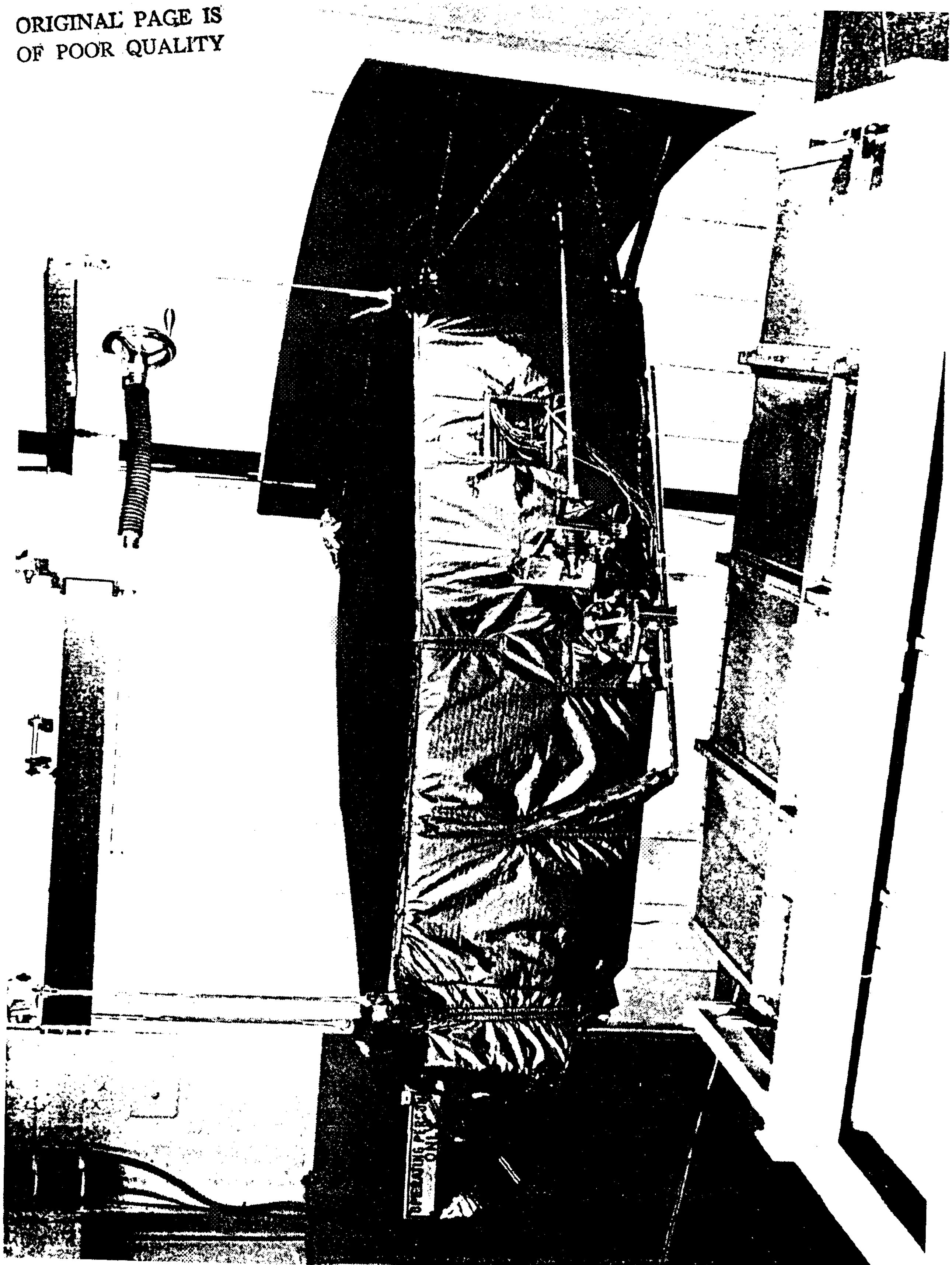


Figure 3

Wide Field/Planetary Camera

WF/PC OPTICAL SYSTEM

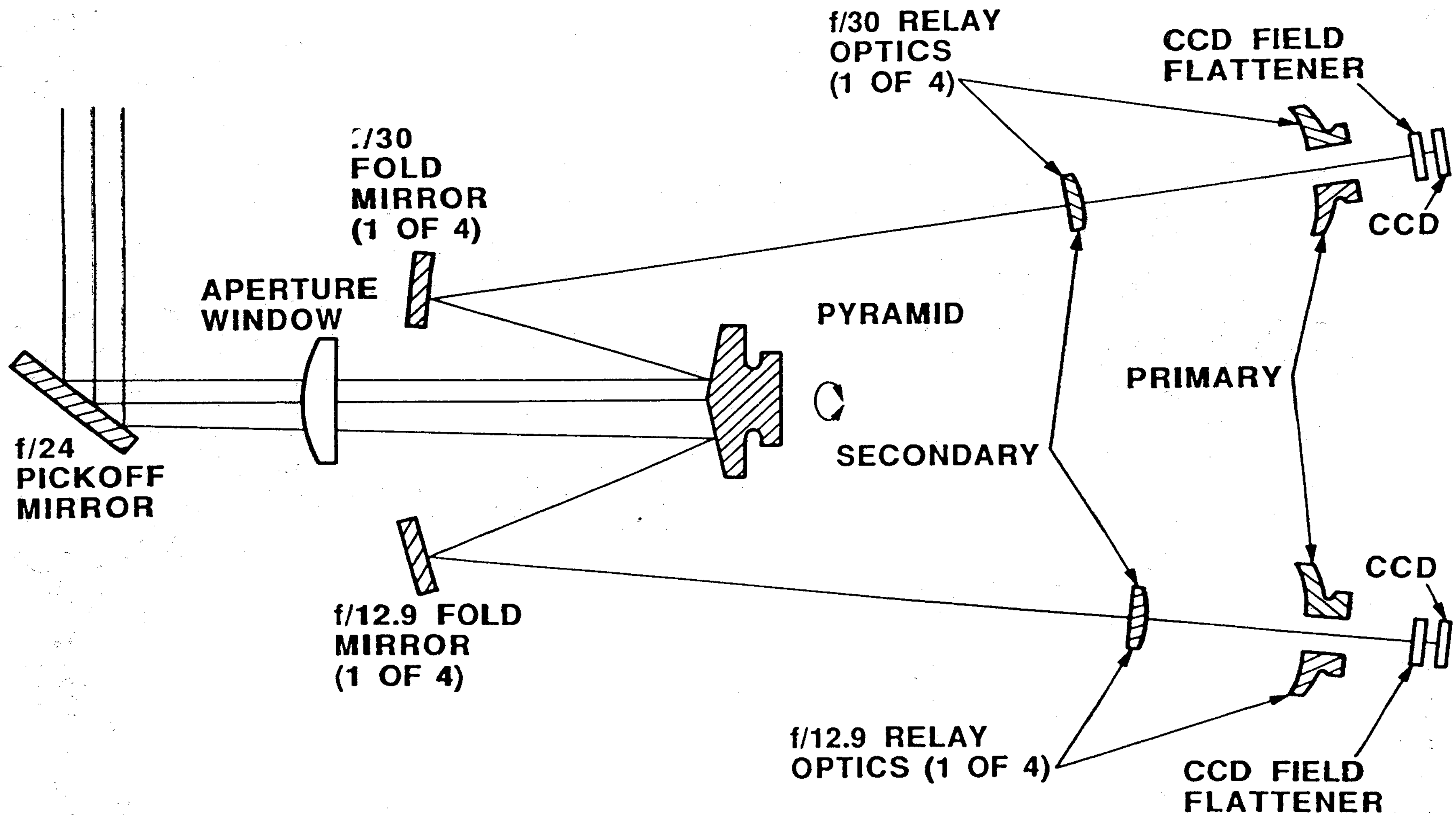
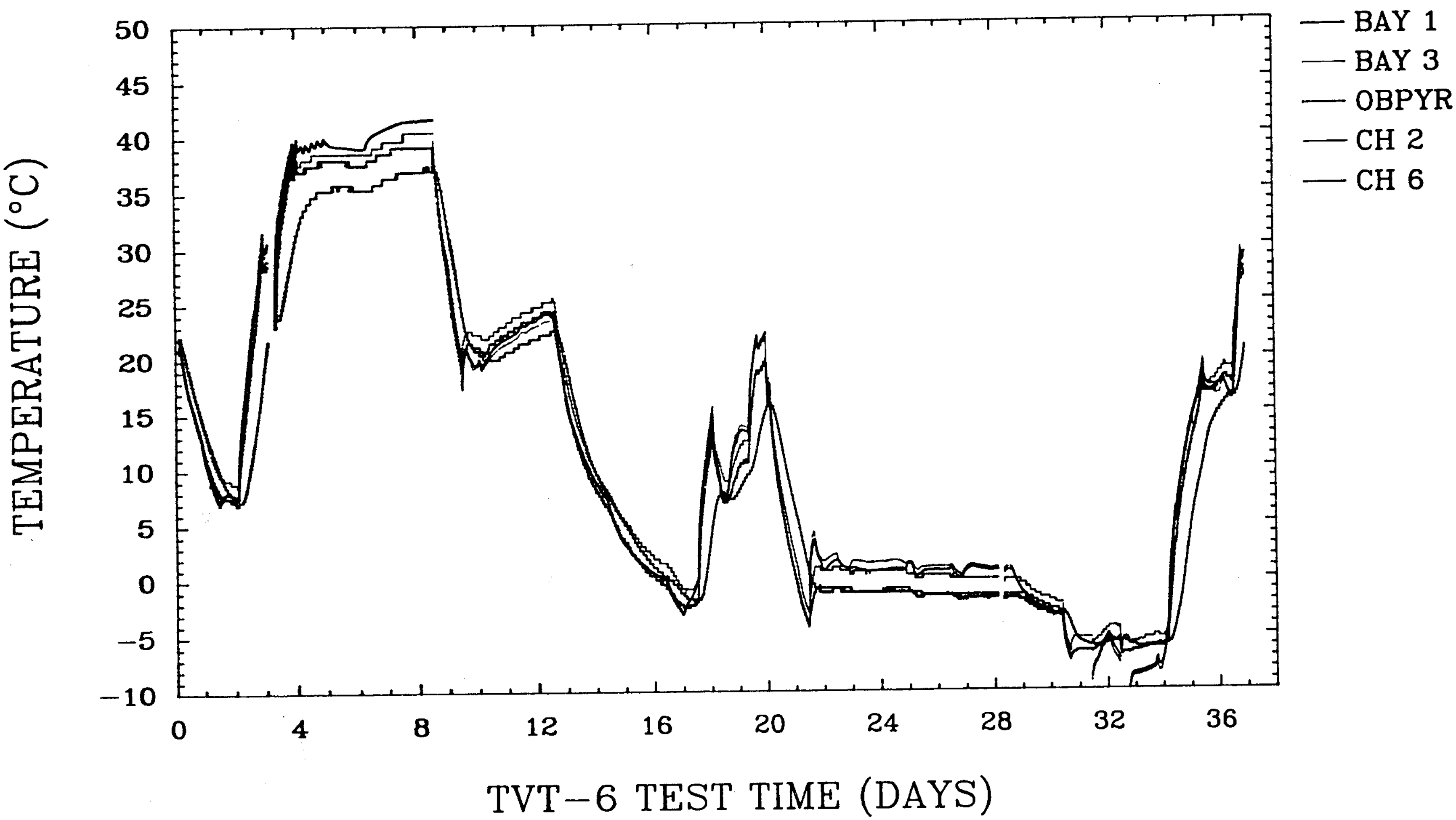


Figure 4



TEMPERATURE (°C)
50
45
40
35
30
25
20
15
10
5
0
−5
−10
0
4
8
12
16
20
24
28
32
36
TVT−6 TEST TIME (DAYS)
BAY 1
BAY 3
OBPYR
CH 2
CH 6

Figure 5

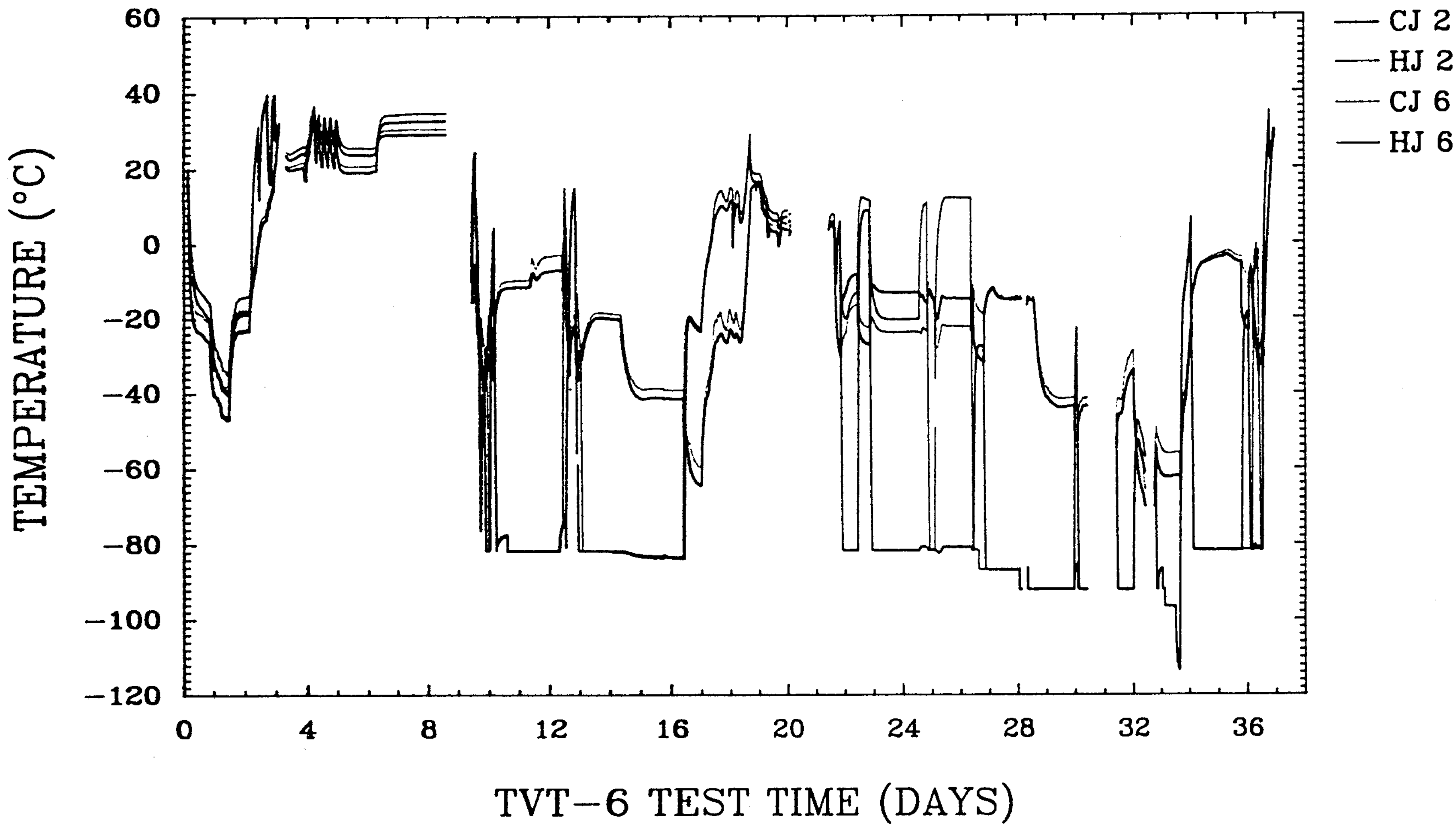

60
40
20
0
−20
−40
−60
−80
−100
−120
TEMPERATURE (°C)
0
4
8
12
16
20
24
28
32
36
TVT−6 TEST TIME (DAYS)
CJ 2
HJ 2
CJ 6
HJ 6

Figure 6

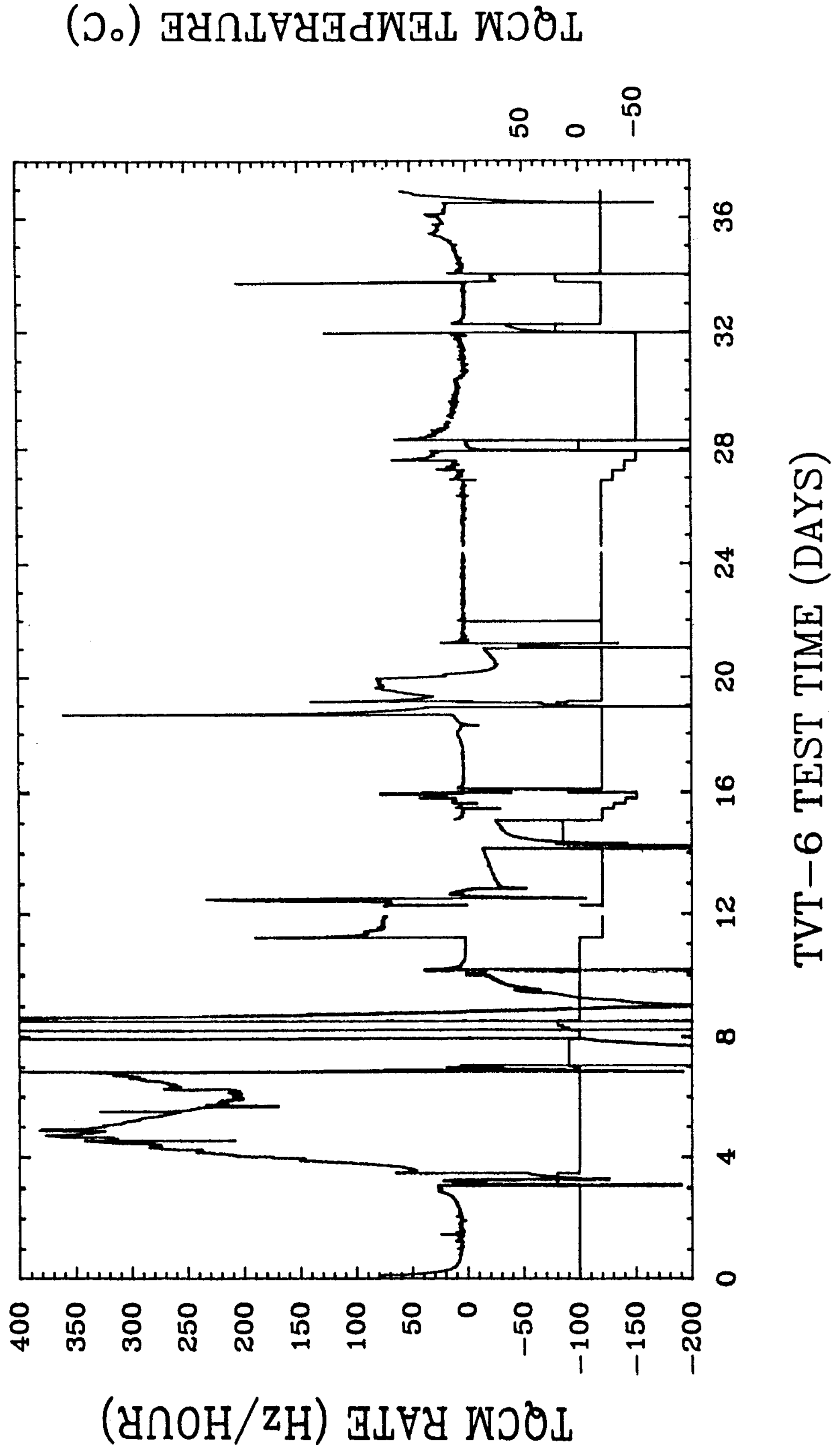

TQCM TEMPERATURE (°C)
50
0
−50
TQCM RATE (Hz/HOUR)
400
350
300
250
200
150
100
50
0
−50
−100
−150
−200
0
4
8
12
16
20
24
28
32
36
TVT−6 TEST TIME (DAYS)

Figure 7

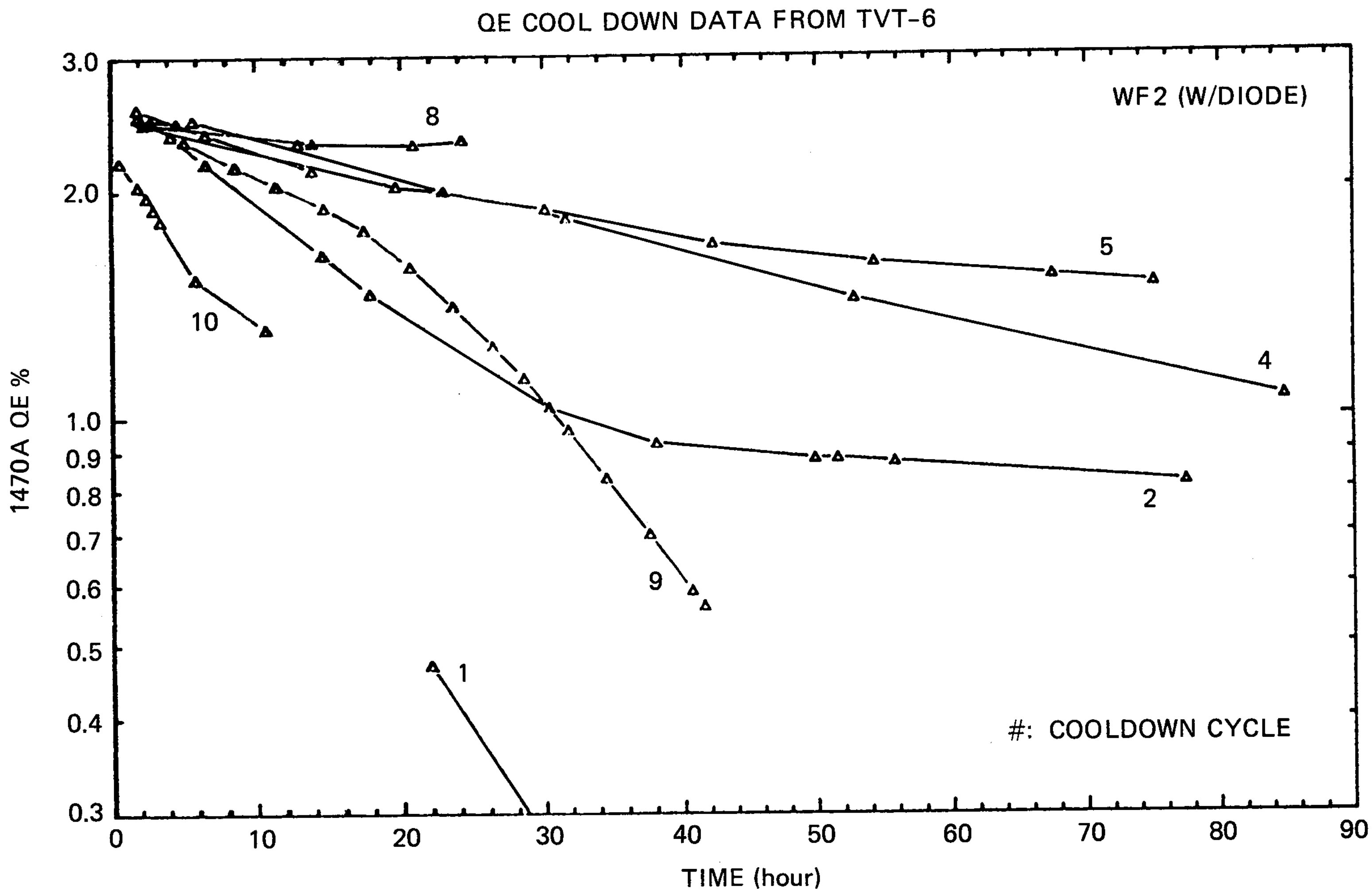

QE COOL DOWN DATA FROM TVT-6
WF2 (W/DIODE)
#: COOLDOWN CYCLE
1470A QE %
TIME (hour)
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
10
20
30
40
50
60
70
80
90
1
2
4
5
8
9
10

Figure 8